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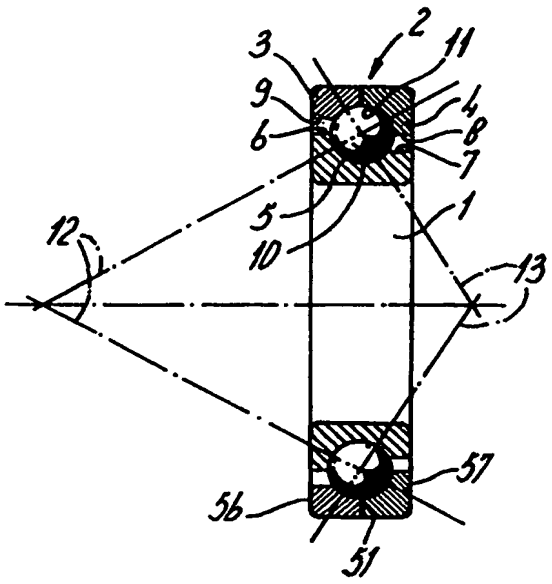
(54) Title: ASYMMETRIC ANGULAR CONTACT BALL BEARING

(57) Abstract

An angular contact ball bearing comprises an inner ring (1) and an outer ring (2) which are each provided with at least one raceway, and at least one series of rolling balls (5) which are in rolling contact with said raceways, which balls and raceways contact each other at four contact points, and two working lines (12, 13) being defined by each pair of opposing contact points of the raceways, which working lines intersect each other. The working lines (12, 13) intersect the axis of the bearing at mutually different angles.



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Asymmetric angular contact ball bearing

The invention is related to an angular contact ball bearing, comprising at least an inner ring and an outer ring which are each provided with at least one raceway, and at least one series of rolling balls which are in rolling contact with said raceways, which balls and raceways contact each other at four contact points, and two working lines being defined by each pair of opposing contact points of the raceways, which working lines intersect each other.

Angular contact ball bearings are widely known, e.g. from "SKF General Catalogue", Catalogue 4000 E, Reg. 47.69000.1989-04, page 285 ff. As an example, a double row angular contact ball bearing is able to accommodate both radial and axial loads which act in both directions. Generally, the contact angles of their load contact angle lines or working lines are about 30°; these working lines each have an identical, but opposite contact angle. A further example is the four-point contact ball bearing, being a single row angular contact ball bearing having raceways which are able to accommodate axial loads in both directions.

These bearings have equal capability in both axial directions. However, in certain applications, the bearing is loaded mainly in one axial direction. This means that its capability for accommodating axial forces in the other direction will not be used, other than for location/centering purposes.

The object of the invention is therefore to provide an angular contact ball bearing which is better adapted to the specific case of loadings which are mainly directed in one and the same axial direction. This object is achieved in that the working lines intersect the axis of the bearing at mutually different angles.

In the bearing according to the invention, the pair of contact points with a working line having an angle with respect to the axis of the bearing which is smaller than the corresponding angle of the other working line, is intended to take the main axial load in the main axial direction. Thus, the bearing is better adapted to such main load.

The specific orientation of the working lines in the bearing according to the invention may be obtained in various ways. According to a compact embodiment, each ring at its facing surface facing the other ring comprises shoulders which axially adjoin the raceway and which have different diameters and as such creating bigger

contact angles. This can be achieved when omitting the cage for the rolling elements and create a full complement rolling bearing.

According to a preferred embodiment, at least one of the rings comprises two axial ring halves. Ring(s) can also be made of sheet metal; also, they may have flanges.

Said axial ring halves have facing radial abutment faces. Once the axial loading on the split ring halves has reached a magnitude such that the abutment faces abut each other, the required preload is obtained of the balls with respect to the raceways.

According to a further possibility, the axial ring halves are connected to each other, and are preloaded in axial direction, by means of a clamping means.

As already addressed, the invention is also related to a double row angular contact ball bearing, wherein at least one of the rings or balls comprises a non-metallic material, such as a ceramic material.

Furthermore, the invention is related to a four-point contact ball bearing, wherein at least one of the ring halves comprises a non-metallic, such as a ceramic material.

The invention will further be described with reference to several embodiments shown in the figures 1-5.

Figure 1 shows a single row four-point contact ball bearing, having an inner ring 1 and an outer ring 2 comprising two outer ring halves 4. A single series of balls 5 has been accommodated between this inner ring 1 and outer ring 2.

The embodiment shown is a full complement bearing, which means that no cage has been included between the inner ring 1 and outer ring 2. Nevertheless, the invention can also be applied to a four-point contact ball bearing which does have a cage.

As shown in figure 1, the inner ring has a shoulder 6 with a relatively large diameter creating maximal contact angle, and a shoulder 7 with a smaller diameter. The raceway is fully filled with balls (full complement). Also, the outer ring half 4 has a shoulder 8 with a relatively small inner diameter, and outer ring half 3 has a shoulder with a relatively large inner diameter. Thereby, the inner raceway 10 and the outer raceway 11 of the inner ring 1 and outer ring 2 respectively are non-symmetrical with respect to the middle plane of the bearing.

The outer ring halves 3, 4 have radial abutment faces 50, 51, which abut each other once an axial compressive load is applied on this radial outer faces 56, 57. Thus, a predetermined preload can be established upon mounting the bearing.

Figure 2 shows an embodiment having an inner ring 14 comprising two inner ring halves 16, 17, and an outer ring 15. The raceways 27, 30 of the inner and outer ring 14, 15 are formed in such a way that the a-symmetric load contact angle line pattern or working line pattern 24, 25 is obtained. Moreover, the outer ring carries a mounting flange 15.

As the bearing in figure 1 is a four-point contact ball bearing, an a-symmetric pattern load contact angle lines or working lines 12, 13 is obtained.

As a result, the four-point contact ball bearing shown in figure 1 has a higher capacity for axial loads which are directed from left to right in figure 1, than in the other direction. This four-point contact ball bearing is particularly fit for loadings in said one direction; although it is able to carry axial loads in the other direction as well, the magnitude of these loads should be significantly lower.

To that end, in this embodiment as well radial abutment faces 52, 53 and radial outer faces 58, 59 have been provided.

Figure 2 shows an embodiment having an inner ring 14 comprising two inner ring halves 16, 17, and an outer ring 15 having a mounting flange 19. The raceways 27, 30 of the inner and outer ring 14, 15 are formed in such a way that the a-symmetric load contact angle line pattern or working line pattern 24, 25 is obtained.

Figure 3 shows an actuator, which for instance can be used as drive means for pressing the brake pads of a disc brake onto the disc. A corresponding actuator has been described fully in a co-pending Dutch patent application No. 1006543.

Said actuator comprises a full complement four-point contact ball bearing 31 which contains one series of rolling balls 32, an inner ring 33 which forms a unity with the nut member of screw mechanism, and an outer ring 34 comprising two outer ring halves 35, 36. These outer ring halves 35, 36 together define a raceway 37, 38; the inner ring 33 defines a raceway 39.

The raceways 37-39 are formed in such a way that four contact points are obtained, comprising two pairs which each define a working line 40, 41.

According to the invention, the raceways 37-39 have been formed in such a way that the working lines 40-41 intersect the axis of the bearing 31 under mutually

different angles. Working line 40 intersects the axis 42 under a greater angle than working line 41. Thus, four-point contact ball bearing 31 according to the invention is in particular fit for taking the axial loads exerted by the brake pads 2, 3 when these are pressed onto the brake disc (not shown).

The particular orientation of the working lines 40, 41 is obtained by an oblique orientation of the raceways 37-39. This orientation results from the relatively large diameter of the inner surface or shoulder 43 of outer bearing ring half 35, and the smaller inner diameter of the inner surface or shoulder 44 of outer ring half 36.

Also, the outer surface or shoulder 45 of the inner ring 34 has a diameter which is larger than the outer surface or shoulder 46 thereof. As in the previous embodiments, radial abutment faces 54, 55 and radial outer faces 60, 61 have been provided.

The embodiment according to figure 4 comprises outer ring halves 3, 4 which are mutually connected by means of a clamp ring 62. Said clamp ring 62 provides the required preload in the bearing.

Figure 5 shows an embodiment as according to figure 4, provided with additional mounting flanges 63, 64.

Claims

1. Angular contact ball bearing, comprising an inner ring (1; 14; 33) and an outer ring (2; 15; 34) which are each provided with at least one raceway (10, 11; 27-30; 37, 38), and at least one series of rolling balls (8; 18, 19; 32) (full complement bearing) without a cage which are in rolling contact with said raceways, which balls and raceways contact each other at four contact points, and two working lines (12, 13; 24, 25; 40, 41) being defined by each pair of opposing contact points of the raceways, which working lines intersect each other, characterized in that the working lines (12, 13; 24, 25; 40, 41) intersect the axis of the bearing at mutually different contact angles.

2. Angular contact ball bearing according to claim 1, wherein each ring, at its surface facing the other ring, comprises shoulders which axially adjoin the raceway (10, 11; 27-30; 37, 38) and which have different diameters and therefore different contact angles.

3. Angular contact ball bearing according to claim 2, wherein at least one of the rings (2; 14; 34) comprises two axial ring halves (3, 4; 16, 17; 35, 36).

4. Angular contact ball bearing according to claim 3, wherein the axial ring halves (3, 4; 16, 17; 35, 36) have facing radial abutment faces (50, 51; 52, 53; 54, 55).

5. Angular contact ball bearing according to claim 4, wherein the axial ring halves have radial outer faces (56, 57; 58, 59; 60, 61) which face away from each other, said radial outer faces (56, 57; 58, 59; 60, 61) being for receiving axial compressive forces so as to ensure mutual contact of the radial abutment faces (50, 51; 52, 53; 54, 55).

6. Angular contact ball bearing according to claim 6, wherein the axial ring halves (3, 4; 16, 17; 35, 36) are connected to each other by mechanical means or by glueing, laser welding, soldering.

7. Angular contact ball bearing according to claim 6, wherein the bearing clearance is positive, negative or zero.

8. Angular contact ball bearing according to any of claims 3-7, wherein the outer ring (2; 34) has two axial ring halves (3, 4; 35, 36).

9. Angular contact ball bearing according to any of claims 3-7, wherein the inner ring (14) has two axial ring halves (16, 17).

10. Angular contact ball bearing according to any of claims 1-9, wherein at least one of the rings (1, 2; 14, 15; 33, 34) or balls (8; 18, 19; 32) comprises a non-metallic material.

11. Angular contact ball bearing according to any of claims 3-8, wherein at least one of the ring halves (3, 4; 16, 17; 35, 36) comprises a non-metallic material.

12. Four-point contact ball bearing according to any of claims 1-11, wherein one series of rolling balls (5) is provided which is in rolling contact with one raceway (10) of the inner ring (1) and one raceway (11) of the other ring (2).

13. Four-point contact ball bearing according to claim 12, wherein the bearing is a full complement bearing.

14. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the raceways of the rings, and/or at least one of the surfaces of the rolling elements, has been obtained by means of hard turning.

15. Angular contact ball bearing according to any of the preceding claims, wherein the bearing is a full-complement bearing.

16. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the rings (15) has a flange (19).

17. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the rings is made of sheet metal.

18. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the rings is provided with grooves for shield or seals.

19. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the rings and/or balls is coated with e.g. a diamond like carbon coating.

20. Angular contact ball bearing according to any of the preceding claims, wherein at least one of the rings is made of (non) metallic powder (PM-technology).

21. Angular contact ball bearing according to any of the preceding claims, wherein an integrated sensor is provided for detecting rotational speed (number of revolutions).

Fig-1

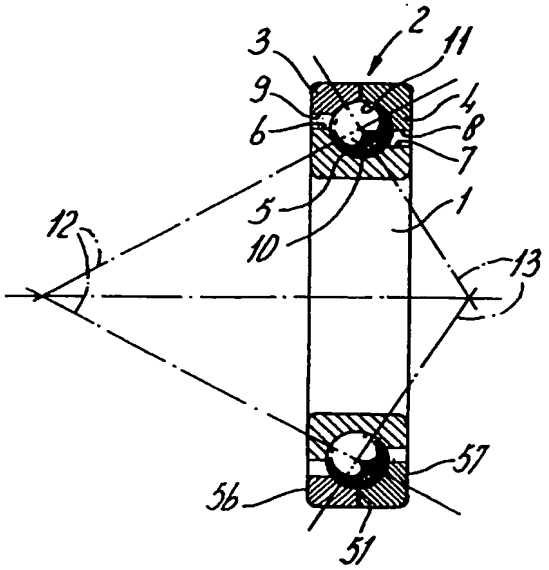


Fig-2

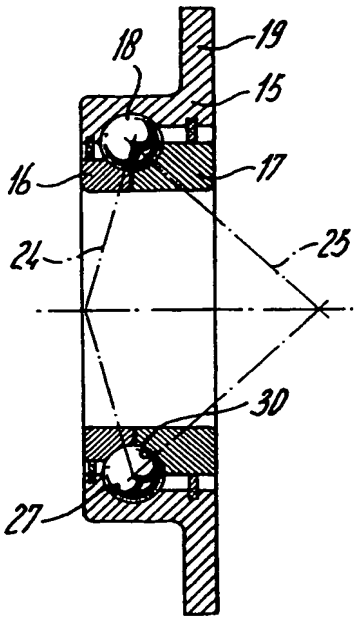


fig-3

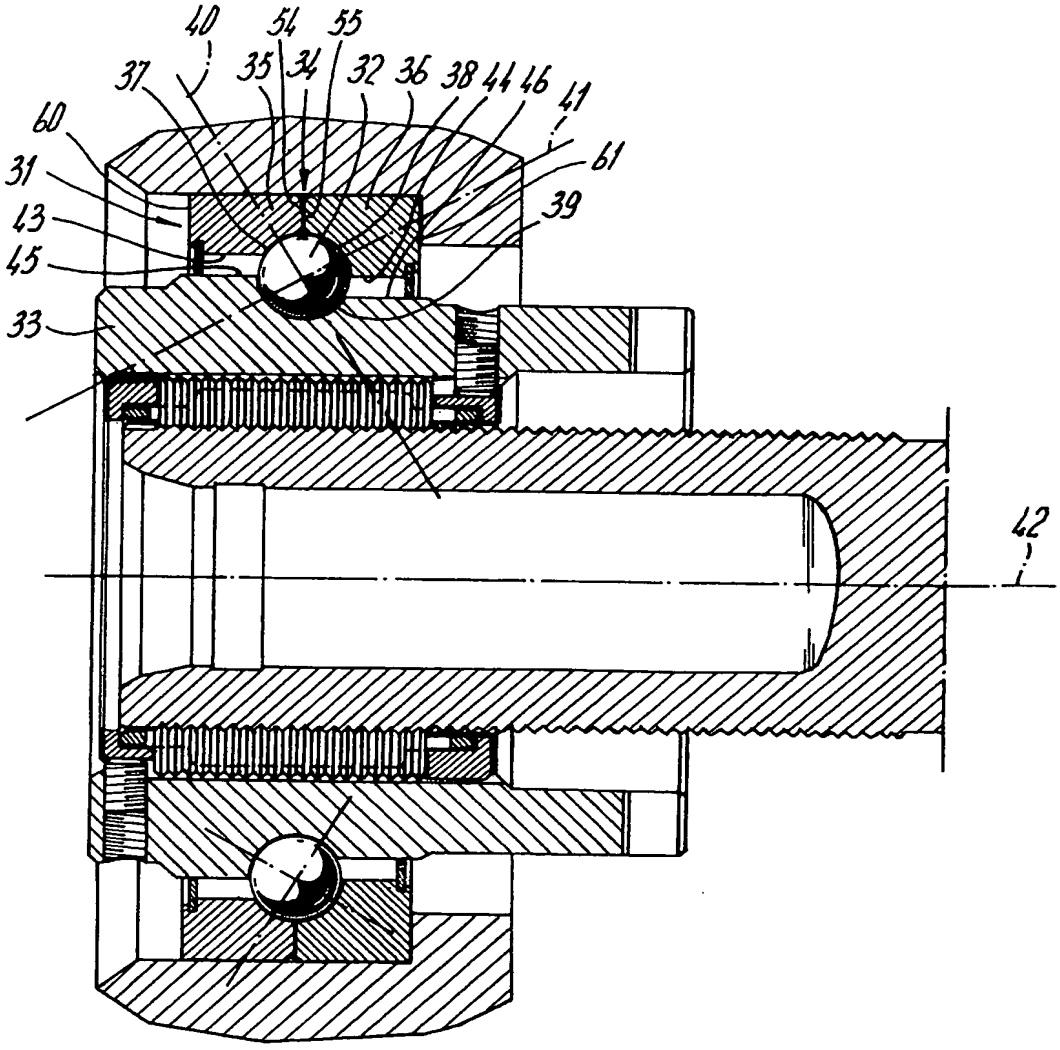


Fig-4

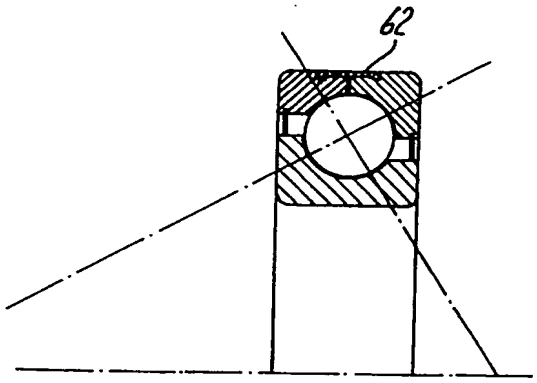
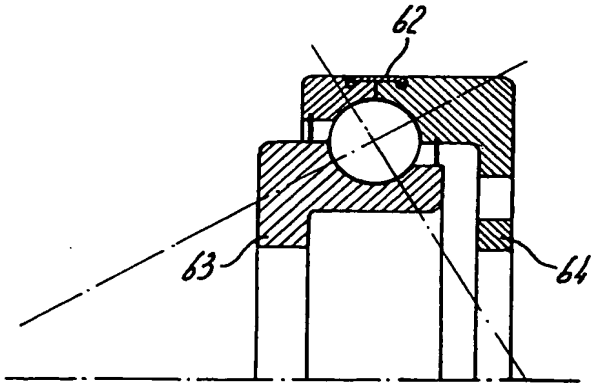


Fig-5



INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16C19/14 F16C33/60

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Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16C B60B

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	DE 30 46 812 A (AUDI) 22 July 1982 see the whole document ---	1,2
X	DE 14 25 933 A (ROTHE ERDE) 20 March 1969 see the whole document ---	1,2
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X	US 4 215 906 A (SPEICHER) 5 August 1980 see the whole document --- -/--	1,12,13, 15

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